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ABSTRACT

If rehearsal can be identified with inner speech and if Vygotsky's theory of the development of inner speech is correct, then it should be possible to disrupt rehearsal by impairing articulation in young children. Performing a delayed short-term memory task with impaired articulation did not lead to a large decrement in performance as compared with unimpaired controls. Hence, either one of the two premises stated above or one of two others on which the study depends is correct. (Author)

REHEARSAL AS INNER SPEECH

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Abstract

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REHEARSAL AS INNER SPEECH

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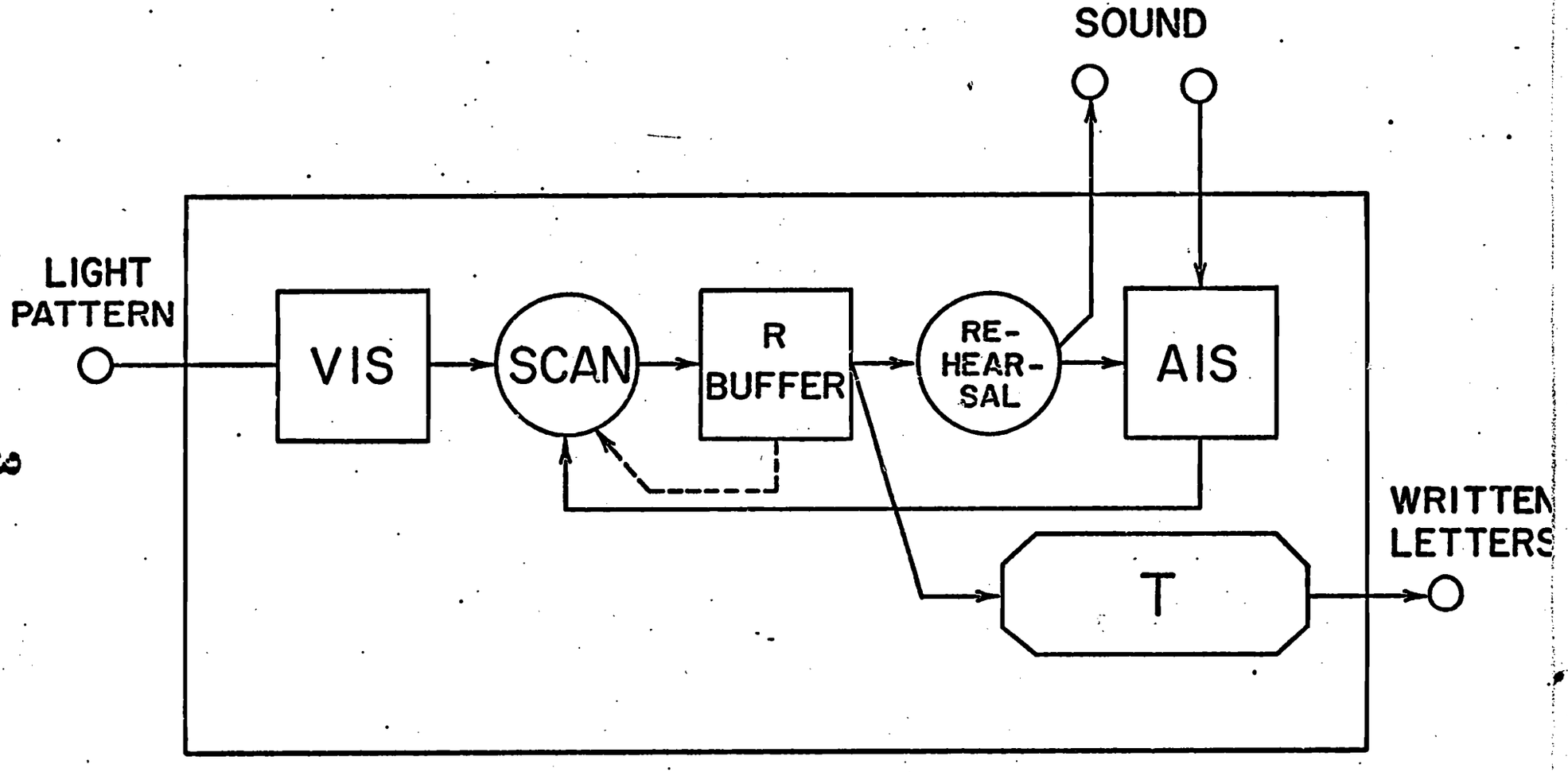
Rehearsal is a concept that has been used extensively, but unfortunately it is not well understood. It has been invoked to explain performance in such a wide variety of situations that it is unlikely that a single process underlies all these uses. Today I would like to talk about rehearsal, but I will restrict the discussion to the rehearsal that may take place when a small set of letters, words, or other verbal stimuli are used repeatly, and tested after short retention intervals. In addition, I would like to concentrate on the process used to maintain items in the short-term store and to ignor as much as possible the process of transferring information to the long-term store.

(Slide 1 please)

Slide 1 shows a model proposed by George Sperling to explain performance in short-term memory experiments and in other experiments. The model uses the concept of rehearsal and describes it as a form of subvocal speech. The R buffer is a small memory store of motor programs. The programs are obtained by scanning either a visual or an auditory sensory memory for the information. Execution of the motor programs leads to overt articulation and external speech. If subjects always rehearsed out loud, the rehearsal loop could be


SOUND
LIGHT PATTERN
VIS
SCAN
R BUFFER
RE-HEAR-SAL
AIS
T
WRITTEN LETTERS

accounted for by the process of reading auditory memory, programming the motor movements, and executing them. The execution of these movements would produce acoustic stimuli which would cause the auditory memory to be reinstated. However, subjects seldom rehearse aloud, so the description is inadequate. Realizing this, Sperling proposed that the motor programs in the R buffer could be executed without overt articulation and yet this execution would cause the information in the motor programs to be transferred to the auditory memory. Thus a major component of rehearsal is this subvocal or inner speech.

Sperling's model is applicable to normal adult subjects, but by combining it with a description of the development of inner speech, an interesting test of the two hypotheses is possible. A theory for the development of inner speech has been proposed by Vygotsky. He argued that initially a child uses speech socially, that is, speech is used mainly to attempt to communicate with other people. At later ages, speech starts to serve two functions. One is social speech as before; the other is egocentric speech, an external talking to himself. Two changes occur with increasing age. First, this egocentric speech is seen to decrease in frequency, so that by ages seven or eight it is infrequent. Second, the character of the egocentric speech which does occur seems to change. With increasing age, when an egocentric utterance occurs there is less doubt that the utterance was egocentric.

To quote Vygotsky, "The structural peculiarities of speech for oneself and its differentiation from external speech increase with age." Because traits of egocentric speech become more distinct with age, Vygotsky argued that the decreasing frequency means that egocentric speech becomes internalized, not that it drops out. In the present investigation it has been assumed that the change from egocentric to inner speech reflects a change in the capacity of the child, either from maturation or learning, and not just a change in the preference of the child for audibly vocalizing. Nazarova's study of spelling which will be described later supports this assumption.

This description of internalization implies that initially a child may have to audibly vocalize to support egocentric functions. Later, he may perform these same functions without actually vocalizing, but articulatory movements may still be necessary to support, for example, the transfer of information from the R buffer to auditory memory. Still later, these articulatory movements become unnecessary or only a very small amount of activity is necessary. Therefore, if rehearsal is one function of inner speech an interesting test is possible. Children who have not yet completely internalized egocentric speech should be forced to make overt articulations in order to maintain their performance on delayed recall tests which require the use of rehearsal. Therefore, if articulation is impaired, the rehearsal loop should be disturbed and performance should be poorer.

There were a number of studies which indirectly suggested to us, and I stress indirectly, that the hypotheses and prediction were not unreasonable. Templin found that articulation was perfected quite late in development. Only by ages seven or eight did all children in her sample correctly articulate all consonants. It is not unreasonable that the capacity to perform a speech act internally depends upon first perfecting that act externally. Thus, speech would not be completely internalized until at least ages seven or eight. McGuigan found that children in grades 1 through 3 made audible vocalizations while reading, but that 3 years later these same children had no audible vocalizations. However EMG activity of the articulators still occurred. While reading is considerably different from rehearsal, if anything, it would probably use inner speech less than rehearsal would.

Nazarova, a Russian investigator, found that young primary school children, who normally mumble when they spell words, spelled less well when they had to hold their tongues between their teeth while spelling. Again, although the relationship between spelling and rehearsal is not clear, a possible link is suggested by some of Luria's work. He described a patient with damage to the left fronto-temporo-parietal region who had a normal memory span and who could spell words correctly, as long as his tongue was free, but

who displayed gross difficulties doing both tasks when he held his tongue in his teeth. Holding his tongue did not have an effect on a variety of other tasks.

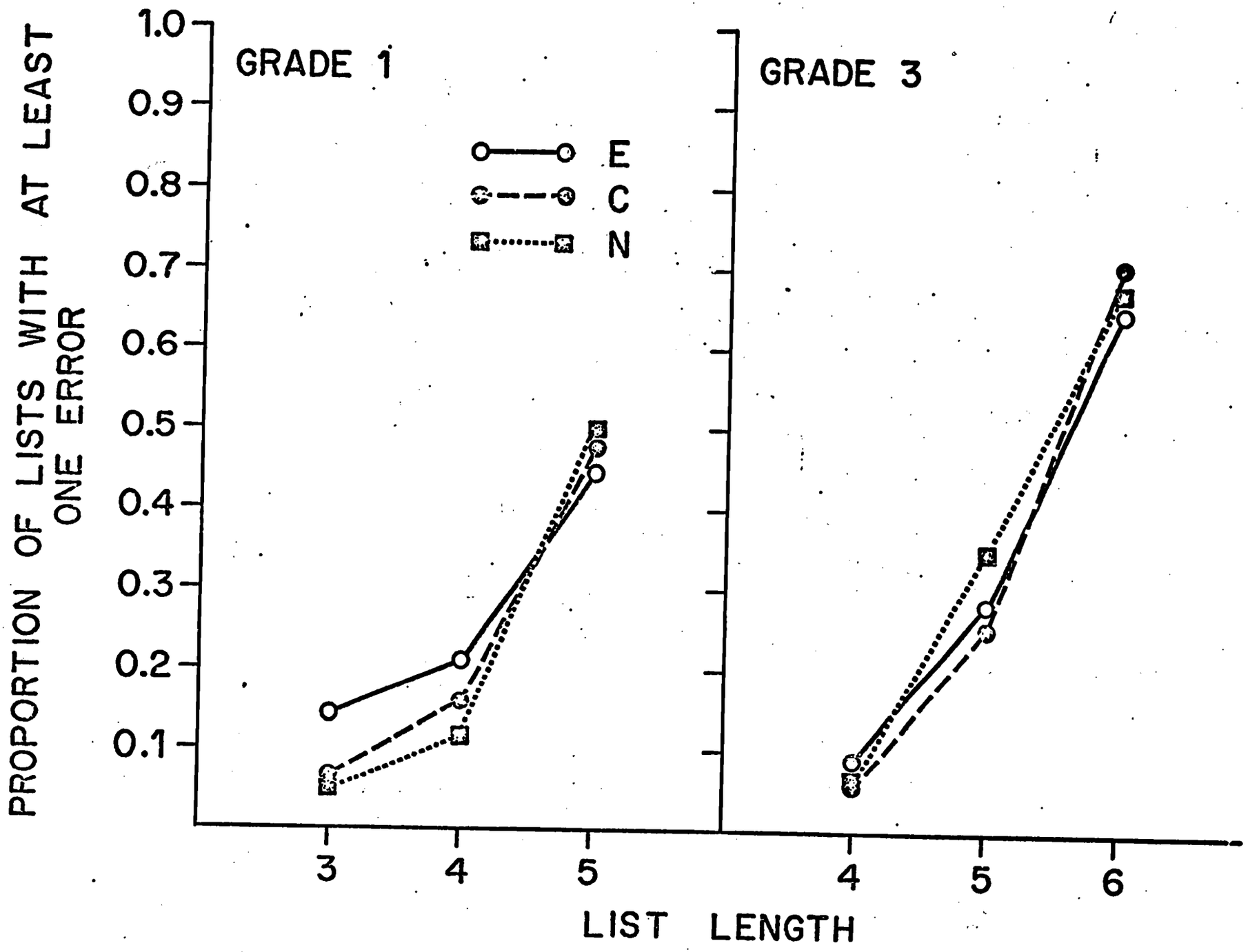
A number of investigators have studied the effects of impairing articulation on performance in memory tasks. Underwood in 1964 reviewed these studies. Generally, impairing articulation had little effect. However, these were studies which either used adults as subjects, or used tasks such as paired associates learning in which rehearsal is probably not an important mechanism. It was encouraging that the one study which seemed to demonstrate the largest effect was one which used a memory span procedure. To test the implications of the two hypotheses, we conducted a study using a delayed serial recall task and using young children as subjects.

Twenty-four first grade and 24 third grade children were tested individually under three different conditions. Each child received three blocks of 15 trials. During one block of trials the child held a tongue depressor crosswise in his teeth, during another he held the edges of a tongue depressor between his thumb and forefinger, and during a third block no other task was performed. If the tongue depressor ever slipped during the presentation, retention or recall periods, the trial was discarded and a new list of the same length was presented at the end of the block of trials. In addition, in each block three different list lengths were used.

On each trial the digits were spoken at a one digit per second rate. A ten second retention interval followed the presentation of the last digit. The end of the retention interval was signaled by turning over the response card which consisted of a 3 by 3 matrix of cells. The cells contained the digits 1 through 9 in a regularly increasing order. To recall, the child pointed at the digits in the correct order. All of the children could point correctly at the digits when they were named just prior to the start of the experimental session. The subjects were given practice on immediate and delayed recall tests with easy lists until they mastered the procedure.

One additional problem has not yet been mentioned. Crowder and Morton have presented evidence for the existence of a precategorical acoustic store, a type of echoic memory, which can aid recall under normal testing conditions, if the items to be recalled are presented acoustically. If impairing articulation reduced the probability of audibly speaking the items during the presentation or retention intervals, then a performance decrement could result from the differential use of this echoic memory. Therefore, subjects were not allowed to audibly speak the digits during the presentation or retention intervals. However, sub jects were free, under the two control conditions, to mouth the digits and to use this to support rehearsal, if necessary.

(Slide 2 please)


GRADE 1
GRADE 3
E
C
N
PROPORTION OF LISTS WITH AT LEAST ONE ERROR
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
3
4
5
4
5
6
LIST LENGTH

Slide 2 shows the main results of this experiment. As you can see there was a large and significant effect of list length. However, both the overall effect of experimental conditions and the interaction of the experimental conditions with list length were clearly not significant for both first and third grade children.

These results imply that either rehearsal does not involve inner speech or that Vygotsky's theory for the development of inner speech is incorrect. However a third possibility also must be considered. The experiment may not have been sensitive enough to measure the predicted effect. In fact because of other considerations we deliberately chose conditions which did not maximize the predicted effect. We were worried about the general distractibility produced by having the child perform a second task and we wanted to minimize the difficulty of using the recall card. For these reasons we did not force the subject, as Underwood did, to hold his tongue fixed under the tongue depressor, because that procedure caused the tongue depressor to slip from the child's mouth much more often. Also, digits were used to help the subject locate his response on the response card. However, digits are phonemically quite dissimilar and, therefore, their representations in memory would be distinct even after they were considerably degraded. We are currently conductiong another study using

a new technique that severely impairs tongue movement. Also, phonemically similar consonants are being used. These conditions will make possible a much more sensitive test of the two hypotheses.

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